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Effect of exercise on cigarette cravings and ad libitum smoking following concurrent stressors

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HIGHLIGHTS

- Exercise provides immediate craving relief in smokers facing concurrent stressors.
- Exercise has no effect on ad libitum smoking.
- Indirect evidence for concurrent stressors and exercise on self-control strength.
- Concurrent stressors deplete self-control strength.
- Exercise replenishes self-control strength.

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ABSTRACT

The health consequences of smoking are well documented, yet quit rates are modest. While exercise has supported decreased cravings and withdrawal symptoms in temporarily abstinent smokers, it has yet to be applied when smokers are experiencing concurrent stressors. This study examined the effect of an acute bout of moderate intensity exercise on cravings (primary outcome) and ad libitum smoking (secondary outcome) following concurrent stressors (i.e., temporary abstinence and environmental manipulation—Stroop cognitive task + cue-elicited smoking stimuli). Twenty-five smokers (>10 cig/day; Mean age = 37.4 years) were randomized into either exercise ($n = 12$) or passive sitting conditions. A repeated measure (RM) ANOVA showed that psychological withdrawal symptoms (a measure of distress) were significantly exacerbated after temporary abstinence and then again after the environmental manipulation for all participants ($p < .0001$, $\eta^2 = .50$). Furthermore, a treatment by time RM ANOVA revealed decreases in psychological withdrawal symptoms for only the exercise condition ($p < .001$, $\eta^2 = .42$). A treatment by time RM ANOVA also revealed craving reductions for only the exercise condition ($p < .0001$, $\eta^2 = .82$). Exercise had no effect on ad libitum smoking. This is the first study to use a lab-based scenario with high ecological validity to show that an acute bout of exercise can reduce cravings following concurrent stressors. Future work is now needed where momentary assessment is used in people's natural environment to examine changes in cigarette cravings following acute bouts of exercise.

1. Introduction

Failure to cope with smoking-related and external stressors may lead to an increased likelihood of relapse and an eventual return to normal smoking behavior (Aveyard & West, 2007). A single bout of light-to-moderate intensity exercise has been shown to significantly reduce cravings in temporarily abstinent smokers (Daniel, Cropley, & Fife-Schaw, 2007; Elibero, Janse Van Rensburg, & Drobes, 2011; Faulkner, Arbour-Nicitopoulos, & Hsin, 2010). Two recent meta-analyses (Haasova et al., 2013; Roberts, Maddison, Simpson, Bullen, & Prapavessis, 2012) provide empirical evidence for acute exercise having a positive effect on cigarette cravings and withdrawal symptoms during abstinence. Moreover, exercise is more than a distraction from cravings and withdrawal symptoms, as benefits of exercise last after the bout is over (Daniel, Cropley, & Fife-Schaw, 2006; Ussher, West, Doshi, & Sampuran, 2006). In addition, treatment expectations are unrelated to reductions in cravings and withdrawal symptoms following an acute bout of exercise (Daniel et al., 2007; Harper, Fitzgeorge, Tritter, & Prapavessis, 2013).

In order to further evaluate the effects of acute exercise for managing cravings and withdrawal symptoms, we argue that it is crucial to

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determine the value of exercise using a cue-elicited smoking research paradigm. Cue-elicited research is originally derived from classical conditioning (Tiffany, 1995). Addicts are exposed to cues related to their addiction (e.g., drug paraphernalia) and psychological and/or physiological responses are measured. Generally, responses are measured through self-report using a measure of craving or desire for the drug. A meta-analysis conducted by Carter and Tiffany (1999) suggests that the cue-elicited research paradigm is useful for basic addiction research and robust for psychological responses.

Taylor and Katomeri (2007) showed that a single bout of exercise could moderate cue-elicited cravings and withdrawal symptoms during a temporary quit period. Following a 2-hour abstinence period, participants were randomized to either a 15-minute brisk walk or passive condition. Both groups completed a set of tasks (i.e., stressors) following their respective treatment conditions. Exercise attenuated strength of desire to smoke, tension, poor concentration and stress in response to a lit cigarette, but had minimal effects on cravings and withdrawal symptoms in response to other stressors (i.e., Stroop task and speech task). Moreover, participants who exercised lit up a cigarette (ad libitum smoking) 57 minutes later than passive controls after leaving the laboratory.

While the study conducted by Taylor and Katomeri (2007) advances knowledge, the cue-elicited stressors were presented after the treatment condition. A more ecologically valid scenario would be to present the stressors immediately after a period of temporary abstinence. This situation mirrors a real life situation where smokers often have to simultaneously deal with cue-elicited stressors along with the stressors associated with abstaining from smoking. The combined effects of both stressors may be greater than the effects experienced when a smoker only engages in a temporary quit attempt. Specifically, the severity of the psychological withdrawal symptoms (a measure of distress) will likely be higher for those experiencing concurrent stressors. This in turn will likely make it more challenging for treatments like exercise to work in attenuating cravings.

Hence, the purpose of this study is to examine the effect of an acute bout of moderate–intensity exercise on cigarette cravings and ad libitum smoking following exposure to concurrent stressors (temporary smoking abstinence period and environmental manipulation—cognitive Stroop task + cue-elicited smoking stimuli). It was hypothesized that all participants would experience an increase in psychological withdrawal symptoms following temporary abstinence (stress condition 1) and a further increase in symptoms following environmental manipulation (stress condition 2). However, it was expected that participants who exercised would show lower psychological withdrawal symptoms after treatment compared to passive controls. It was also predicted that, compared to passive controls, those who exercised would experience lower cravings and would take longer to light up their first cigarette following exposure to the concurrent stressors.

2. Materials and methods

2.1. Design

This study used a stratified (age and sex), two-group (moderate intensity exercise and passive sitting) randomized controlled trial design. A computer-generated numbers table accomplished randomization for age (18–30 years, 31–50 years, 51–65 years) and sex (male, female). Participants were blinded to the existence of a second condition.

2.1.1. Sample size calculation

Previous research has shown Shiffman–Jarvik withdrawal symptoms psychological subscale scores of 2.55 at baseline increases to 3.72 (standard deviations not reported by authors) after a 13–16 hour period of temporary abstinence (Canamar & London, 2012). Moreover, no previous research exists to inform power analysis for psychological symptoms after temporary abstinence and environmental manipulation (concurrent stressors). It is anticipated that the additional environmental stressor will likely elevate psychological symptoms from 3.72 to 4.2 ($SD = 1.0$). Hence, in order to be adequately powered (.80) to detect this difference, a sample size of 25 smokers is needed with the alpha set at 0.05. Our sample size calculation for strength of desire to smoke (primary outcome) was based on previous research (Roberts et al., 2012) that showed a difference of −2.41 (SD = 2.0) between exercise and passive conditions within 5 min of post-treatment. Thus, a sample of 11 smokers per group was needed to detect similar differences in this variable at a power of .80 with an alpha of .05 (SamplePower 3, IBM-SPSS).

2.2. Participants

After receiving ethical approval from the host university, healthy male and female smokers were recruited using advertisements in local newspapers and online classifieds in the local community. Smokers were eligible if they were 18–65 years of age; smoked an average of 10 cigarettes or more per day for at least two years; and had no contraindications to physical activity as determined by the Physical Activity Readiness Questionnaire (Thomas, Reading, & Shephard, 1992). Females who were pregnant or intending on becoming pregnant before completion of the study and those who were unable to temporarily abstain from smoking for 18 h were ineligible. Thirty-six participants had given consent and were randomized, but participants were ineligible due to an inability to abstain for 18 h ($n = 5$), lost contact ($n = 4$), or lost interest ($n = 2$). Twenty-five participants satisfied all criteria and completed the study.

2.3. Measures

2.3.1. Psychological distress (fidelity check)

Psychological distress was measured with the Shiffman–Jarvik withdrawal scale (Shiffman & Jarvik, 1976). Five items were measured on a 7-point Likert scale anchored at 1 *definitely do not feel* and 7 *definitely feel*. Only this subscale of the Shiffman and Jarvik inventory was administered, as it represented items (e.g., "*do you feel more tense than usual*?") that directly assessed psychological distress and would likely change from baseline to post-abstinence (stress condition 1) and then again from post-abstinence to post environmental manipulation—cognitive Stroop task + cue-elicited smoking stimuli (stress condition 2). Internal consistency (Cronbach's alpha) for the subscale was acceptable: baseline $\alpha = .73$; post-abstinence $\alpha = .82$; post-environmental manipulation $\alpha = .80$; 2-minutes post-treatment $\alpha = .76$.

2.3.2. Cravings (primary outcome)

Cigarette cravings were measured using the strength of desire to smoke scale (West, Hajek, & Belcher, 1989). This scale uses a single item 'How strong is your desire to smoke right now?' and is scored on a 7-point Likert scale from 1 *not at all* to 4 *somewhat* and 7 *extremely*. A single-item measure of cravings is considered appropriate for assessing reactivity in situations where cravings are expected to be high, and there are a large number of repeated assessments over a short period of time (Sayette et al., 2000).

2.3.3. Time to first cigarette (secondary outcome)

Ad libitum smoking was calculated as the difference in time (min) from leaving the laboratory after post-abstinence assessment to the time (min) of their first cigarette. This method is consistent with previous research in acute smoking research designs (Taylor & Katomeri, 2007). Participants either emailed the study's email address or called and left a message on a secure phone line with the time and date of their first cigarette.